METHOD FOR WINDING STRIPS ON THE TIRE BUILDING MACHINE

BACKGROUND OF THE INVENTION

Technical Field

The inventions disclosed in this application relate to methods for winding an automotive tire building strip member on a building drum.

More particularly, the first invention in this application provides a method for winding a strip member such as rubberized steel cord, tread rubber or the like precut to the circumferential length of the building drum of a tire building machine, on said building drum in such a manner that both ends of the strip member will be exactly abutted against each other on the drum.

The second invention in this application relates to an automotive tire building device wherein the lapping margin of ends of a strip member wound on its building drum can be automatically measured.

Prior Art

In winding a tire strip member on a building drum, it is at times required to insure exact abutment of its ends and at other times required that the lapping margin (positive and negative) be within certain allowable limits.

As a technology for insuring exact abutment of
both ends of a strip member such as rubberized steel
cord or tread rubber in the winding thereof on the
building drum of an automotive or other tire building
machine, there is known the method described in Japa-
nese Patent Publication No. 61-32980. According to
this method, the length of the strip precut to the
circumferential length of the building drum is measured
and, then, a leading portion, of predetermined length,
of the strip is taken up on the building drum at the
feeding (takeup) speed equal to the peripheral speed of
the drum. Then, the feeding speed relative to the
building drum speed is altered to either compress or
stretch the strip while its intermediate portion is
wound on the building drum. Finally, the feeding speed
is re-equalized with the peripheral speed of the
building drum to wind up the remaining portion of the
strip member on the drum.

However, the strip member tends to shrink with the
progress of time after cutting and the time to termina-
tion of shrinkage and the amount of shrinkage are
dependent on the environment and other conditions.
Under certain conditions, the amount of post-cutting
shrinkage reaches as much as about 0.5%. Mor over, the
length of the strip member varies with the magnitude of

the tension that acts on the strip when it is trans-
ferred from a transfer conveyer to the building drum
and the pressure of contact between the strip and the
drum. In the prior art method mentioned above, the
total length of the strip member is measured while it
is undergoing shrinkage after cutting and the ratio of
the feeding speed to the peripheral speed of the
building drum is set according to the length value thus
found so as to compress or stretch the intermediate
portion of the strip. As a consequence, the aforesaid
ratio is often irrelevant and there occurs an excess or
a shortage of compression or stretching of the strip
member, thus causing a lapping of the leading and
trailing ends of the strip member or a gap there-
between.

Therefore, the first invention in this application
provides a winding method which insures exact abutment
of said ends or abutment without an appreciable overlap
or gap.

Furthermore, in the process of manufacture of an
automotive tire, not only the steel cord and tread
rubber mentioned above but a variety of other rubber-
based strip members are cut to length and both ends
thereof are joined to build single-layer or multi-layer
ring or cylindrical members. For example, on the

primary building machine, an inner liner (a strip member of rubber) and a plurality of ply cords (rubberized fiber cords or steel cords), all precut to the circumferential length of the building drum, are laid up on the peripheral surface of the drum. In the secondary building machine, two steel belts (rubberized steel cords), a cap ply (rubberized nylon cord), etc. are laid up. Some of these different strip members are not joined by abutment at ends as described above but are joined by lapping the trailing end over the leading end on the drum. As mentioned above, the strip member has the property to shrink on standing after cutting to length as mentioned above and the amount of this shrinkage varies with changes in environment. Also as mentioned above, the length of the strip member is altered by external forces that act on the strip when it is transferred from the conveyer to the drum. Therefore, even if the strip member has been cut precisely to length, a variation is inevitable in the degree of lapping of both ends. Therefore, it is common practice for the operator to trim off the rubber or cord at the trailing end when the degree of lapping is too large or unwind the strip partway and rewind it with stretching when there is a gap between ends.

However, the conventional tire building machine is

not equipped with very effective means for inspecting the end joint of said strip member and the current trend toward automation of tire building cannot completely avoid a risk of products with said surplus or deficiency in end lapping being shipped uncorrected and marketed.

Accordingly the second invention in this application provides a tire building device which is capable of detecting a surplus or deficiency in end lapping while a strip member is wound on a building drum of said primary or second building machine.

SUMMARY OF THE INVENTION

The method for winding a strip member on a tire building machine in accordance with the first invention in this application comprises feeding a strip member to a building drum by means of a transfer conveyer, taking up said strip member on said building drum while controlling the speeds of said transfer conveyer and building drum and joining free ends of the strip member, which method is characterized by setting the feeding speed of said transfer conveyer and the peripheral speed of said building drum to equal values, taking up a leading portion, of predetermined length, of said strip member on the building drum, detecting the position of a trailing end of said strip member on

said transfer conveyer to calculate the length of a
trailing portion following said leading portion of said
strip member, setting the ratio of the feeding speed of
said transfer conveyer to the peripheral speed of said
building drum to the ratio L/Lo, where L is the length
of said trailing portion and Lo is the residual circum-
ferential length of said building drum, only when the
L/Lo ratio is within a set range and taking up the
trailing portion of said strip member, while the takeup
of the trailing portion of said strip member is stopped
when the ratio L/Lo deviates out of said set range.

Thus, after completion of the takeup of a leading
portion of the strip member or just before the begin-
ning of takeup of a trailing portion of the strip
member, the length of the trailing portion is measured
and the trailing portion is wound only when the ratio
L/Lo of the length of the trailing portion of the strip
member to the residual circumferential length Lo of the
building drum is within a set range, with the ratio of
the feeding speed to the peripheral speed of the
building drum being set to said ratio L/Lo, with the
result that the error of length L of the trailing
portion of the strip member is minimized to preclude an
excessive overlap or gap between ends of the strip
member, thus leading to exact abutment of the ends or a

minimum of overlap or gap.

The length of the leading portion of said strip member is preferably set to 30 ~ 80% of one circumferential length of the building drum. If the set length is less than 30%, installation of a leading end sensor is difficult. Conversely if the set length is over 80%, the stretching or compression of the strip member is concentrated in the trailing portion thereof to adversely affect the quality of the product.

The said ratio L/Lo applicable to the case of continued takeup of the trailing portion of the strip member is preferably set within the range of 0.995 ~ 1.005. Outside of this range, the amount of stretching or compression becomes too great to insure the proper winding.

The method of winding the strip member in accordance with the second invention in this application comprises using a tire building machine having a building drum for taking up a tire-building strip member of predetermined length endlessly and a transfer conveyer for feeding said strip member to said building drum, which method is characterized by detecting the winding-start end of said strip member transferred from said transfer conveyer to said building drum and the winding-finish end of said strip member with end

sensors, measuring the angle through which said build-
ing drum has rotated from the output of a winding start
signal to the output of a winding finish signal in
response to output signals from said sensors by means
of an angle detector, and calculate a lapping margin
between the winding start end and the winding finish
end of said strip member based on the rotational angle
and diameter of said building drum by means of an
operational means.

In the above method, since the lapping margin
between the two ends of the strip member is calculated
by said operational means, the building operation can
be continued while said lapping margin is within a
preset allowable range or the operation can be dis-
continued or an alarm be actuated when the lapping
margin deviates out of said allowable range, that is to
say when the lapping margin is too large or too samll.
Therefore, in the automatic building process for car
tires, the risk of products with lapping defects being
shipped can be effectively prevented.

It may be so arranged that one end sensor of the
above-described type is used to detect both the winding
start and winding finish ends of the strip member or
that two such end sensors are installed apart from each
oth r by an optional angle along the circumferential

direction of the building drum so that one of the sensors is used to detect the winding start end with the other sensor deteting the winding finish end.

Furthermore, a still more improved accuracy may be insured by installing end sensors in a plurality of positions, for example in the center and in positions on both sides thereof. Moreover, to cope with the case in which one strip member has an intermediate joint of material and this joint builds a step, it may be so arranged that the trailing end sensor is rendered operative only within a certain range, for example in the range of 5 mm, before and after the winding start end, whereby the risk of said joint being mistaken for the winding finish end and detected as such.

In the second invention in this application, the lapping margin of the strip member wound on the building drum includes both a positive value and a negative value. In other words, the case in which the two ends of the strip member actually overlap and the case in which there is a gap between the ends are included. The winding operation is stopped when the actual overlap or gap is too great or too small.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic view showing an example of the first invention in this application.

Fig. 2 is a view similar to Fig. 1, showing an example of the second invention in this application.

Figs. 3 and 4 each is a schematic side view of the building drum, which explains the operation of the example shown in Fig. 2.

PREFERRED EMBODIMENTS OF THE INVENTION

Fig. 1 shows an example of the first invention in this application.

As illustrated, A stands for a tire steel belt, that is to say a strip member, 1 for a transfer conveyer therefor, 2 for an end pulley, 3 for a guide pulley, 4 for a drive pulley, and 5 for a building drum. The drive pulley 3 is connected to a drive shaft of a transfer servo motor 6 and the rotation of this servo motor 6 is controlled by a transfer servo amplifier 7. The rotational speed of said transfer servo motor 6 is detected by a pulse oscillator 8 and fed back to said servo amplifier 7. On the other hand, said building drum 5 is connected to a drive shaft of a drum servo motor 9 and the rotation of this drum servo motor 9 is controlled by a servo amplifier 10. The rotational speed of said drum servo motor 9 is detected by a pulse oscillator 11 and fed back to said servo amplifier 10.

Disposed over said building drum 5 is a leading

end sensor 12 for contactless detection of a front end
Aa of said strip member A and the output of said
leading end sensor 12 is connected to a sensor ampli-
fier 13. On the other hand, a trailing end sensor 14
for detecting the position of the trailing end Ab of
strip member A is installed over the transfer conveyer
1. The output terminals of this trailing end sensor 14
and said sensor amplifier 13 are respectively connected
to a trailing length meter 15 for calculating the
length L of a trailing portion (the length from point P
to Ab) of said strip member A. When the leading
portion of strip member A is progressively wound on the
building drum 5 and the leading end Aa of strip member
A is detected by said leading end sensor 12, the
trailing end sensor 14 detects the position of the
trailing end Ab of strip member A and said trailing
length meter 15 calculates the length L of the trailing
portion of A which is still to be wound on the building
drum 5.

The output terminal of said trailing length meter
15 is connected to a speed ratio calculator 16. This
speed ratio calculator 16 calculates the ratio L/Lo of
the length L of said trailing portion to the length of
strip member A which is still to be wound on the
building drum 5, that is the residual circumferential

length Lo (length from point P to Aa) and transmits a
signal corresponding to this ratio to said transfer
servo amplifier 7 and drum servo amplifier 10. Only
when said ratio L/Lo is within a set range, the trans-
fer conveyer 1 and building drum 5 are driven at a
speed ratio corresponding to the ratio L/Lo. On the
other hand, when the ratio L/Lo deviates from said set
range, the transfer conveyer 1 and building drum 5 are
respectively stopped.

In winding a strip member A having a total length
of 2,000 mm on a building drum having a circumferential
length of 2,000 mm, the length of the leading portion
of strip member A is set to 1,500 mm (75% of the total
length) and the speed of the transfer conveyer 1 and
the peripheral speed of the building drum 5 are set to
the same value. In this condition, the leading por-
tion, which is 1,500 mm long, of said strip member A is
taken up on the drum. As the leading end Aa of this
strip member A is detected by the leading end sensor 12,
the trailing end sensor 15 is caused to detect the
position of the trailing end Ab of strip member A and
the trailing end length meter 15 to calculate the
length L of the trailing portion of the strip member A.
Then, the ratio L/Lo of this length L of the trailing
portion to the known residual circumferential length Lo

of the building drum 5 is calculated and when this ratio L/Lo is within the range of 0.995 to 1.005 (when L-Lo is -2.5 mm ~ 0 mm), the ratio between the peripheral speed of the building drum 5 and the feeding speed of the transfer conveyer 1 is set to said L/Lo so that the strip member A is taken up under tension, i.e. under a stretching force, on the building drum, whereby the leading and trailing ends of the strip member A are exactly abutted against each other without any surplus or deficiency. However, when the ratio L/Lo deviates from the above-mentioned range, the transfer belt 1 and the building drum 5 are respectively stopped and the strip member A is removed.

Figs. 2 through 4 show an embodiment of the second invention in this application.

Referring to Fig. 2, A stands for a strip member, 1 for a transfer conveyer, 2 for a belt pulley and 5 for a building drum. The building drum 5 and transfer conveyer 1 are driven in the direction of the arrowmark to wind the strip member A on the building drum 5.

Along the path in the direction of advance of said building drum 5 from point P where the strip member A begins to contact the drum 5, there are provided a first end sensor 25 and a second end sensor 26. These end sensors 25 and 26 each comprises a photoelectric

element which photoelectrically detects the end of the strip member A. Connected to said building drum 5 is an angle detector 30 through a toothed pulley 27, a toothed belt 28 and a toothed pulley 29. The output terminals of said first end sensor 25, second end sensor 26 and angle detector 30 are respectively connected to an operational unit 31 which calculates a degree of end lapping of said strip member A.

In the above arrangement, as the building drum 5 and transfer conveyer 1 are driven to take up the strip member A on the building drum 5 and the leading end Aa of said strip member A reaches the position of said first end sensor 25, the angle detector 30 is actuated and as the same leading end Aa then reaches the position of said second end sensor 26, the angle of rotation of said building drum 5 from the time of detection of the leading end Aa by the first end sensor 25 to the time of detection of the same end Aa by said second end sensor is measured. Then, based on this measured angle of rotation, the angle θ_0 (degrees) from the second end sensor 26 to the first end sensor 25 is calculated and stored by said operational unit 31 and, at the same time, the indicator of the angle detector 30 is reset to zero. Then, as the first end sensor 25 detects the trailing end Ab of strip member A (Figs. 3 and 4), the

building drum 5 stops rotating and the angles of rotation θ_1 and θ_2 (degrees) are measured.

Fig. 3 shows the situation where the angle of rotation θ_1 (degrees) is larger than the angle θ_0 between the two end sensors 25 and 26 and the end Aa and Ab of the strip member A overlap. The lapping margin X in this situation is defined as follows.

$$(D + 2t)\pi \times \frac{\theta_1 - \theta_0}{360} = X$$

where D is the diameter of the building drum 5 and t is the thickness of strip member A.

This value of X is calculated by said operational means 31.

Fig. 4 shows the situation where the angle of rotation θ_2 (degrees) is smaller than the angle θ_0 between the two end sensors 25 and 26 and there is a gap between the ends Aa and Ab of the strip member A. The gap Y in this situation is given by the following equation

$$(D + 2t)\pi \times \frac{\theta_0 - \theta_2}{360} = Y$$

where D is the diameter of the building drum 5 and t is the thickness of the strip member A.

This value of Y is calculated by said operational means 31.

While the above embodiment employs two end sensors 25 and 26, the second end sensor 26 shown in Fig. 2 may be dispensed with and only the first end sensor 25 be used to determine the angle corresponding to approximately one turn. However, when two end sensors are used in the above embodiment, the change in length between the two sensors 25 and 26 can be disregarded and a more accurate measurement can be realized. It should be understood that in building the second and subsequent layers of strip member A, the thickness of strip member A already taken up is added to the diameter D of the building drum.